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A MANUFACTURING METHOD OF A LIQUID CRYSTAL DISPLAY DEVICE

[Abstract]

PROBLEM TO BE SOLVED: To provide a method for manufacturing a liquid crystal display device in which irregularity in display can be suppressed and uniformity in display can be improved.

SOLUTION: In the method for manufacturing a liquid crystal display device, a sealing material is applied to form a sealing part on the edge part of at least one substrate of a pair of substrates having electrode layers subjected to alignment treatment, a specified amount of a liquid crystal is dropped onto the region inside of the sealing part of the substrate which a spacer material is fixed on the other substrate, the substrates are laminated and the sealing

material is hardened to produce a panel. In this method, at least one of the pair of substrates is housed in a vacuum chamber and the chamber is evacuated to remove unnecessary substances depositing on the substrate before both substrates are laminated.

[Claim(s)]

[Claim 1] A method for manufacturing a liquid crystal display device, wherein a seal portion is formed by coating a seal member on a periphery of at least one substrate of a pair of substrates having an electrode to which an orientation process is applied, a predetermined amount of liquid crystal is dropped into an inside of the seal member of the substrate, a spacer member is adhered on one substrate, and a panel is formed by attaching the substrates, and curing the seal member is characterized in that at least any one of the pair of substrates is provided into a vacuum container before attaching the substrates, and unnecessary attachment attached on the substrate is eliminated by reducing a pressure in the vacuum container.

[Claim 2] The method of manufacturing a liquid crystal display device of Claim 1, wherein the substrate on which the seal member is coated is provided into a vacuum container before dropping the liquid crystal, and then the pressure is reduced.

[Claim 3] The method of manufacturing a liquid crystal display device of Claim 1 or 2, wherein the substrate on which the spacer is attached is provided into a vacuum container, and then the pressure is reduced.

[Claim 4] The method of manufacturing a liquid crystal display device of any one of Claim 1 to 3, wherein the pressure of vacuum container is reduced to below 133.3 Pa.

[Title of the Invention]

A MANUFACTURING METHOD OF A LIQUID CRYSTAL DISPLAY DEVICE

[Detailed Description of the Invention]

[Field of the Invention]

The present invention relates to a manufacturing method of a liquid crystal display device which have excellent properties in terms of reliability and uniformity of an device.

[Description of the Prior Art]

An LCD device is a display device which changes an initial orientation direction of an liquid crystal into other orientation state by a process using anisotropy of an liquid crystal, and uses a change of an optical property related to the direction change. Compared with a conventional display device, a light-weighted and thin display device which can be driven at a low voltage, is suitable for LSI driving, and consumes low power is being developed. Development of a product which can be mounted on OA, and VA devices is being progressed as a big-sized screen, and a large-capacity are required recently.

Presently, STN display of a simple matrix type, or TFT display of ac active matrix type using the change of a layout state of an liquid crystal due to an application of an electromagnetic field, that is, an optical property are being mounted on each product according to each characteristics.

An LCD device had a sandwiched structure in which an liquid crystal is injected between two glass substrates on which the transparent electrode layers are formed. An orientation layer for orientating an liquid crystal is formed on the transparent electrode. For example, in STN method, the thickness of a cell between the substrates is 5-7 micro meter, an orientation of an liquid crystal is controlled by an orientation layer so that a pre-tilt angle of 3 - 8 degree is obtained. According to STN method, it is possible to obtain a transmissivity property for a voltage showing a sharp change by changing an orientation direction of an liquid crystal into 180 - 270 degree between two substrates. Because of it, a precise control of a cell thickness is necessary and the precision of a cell thickness of 0.05 - 0.1 micro meter is required in order to suppress a display smear created due to imbalance of a threshold voltage.

Below, a conventional manufacturing method of an liquid crystal display device using a dropping process will be explained with referring to a

STN method. First of all, a glass substrate having a transparent electrode such as ITO on one peripheral side is washed, and then, for example, a coating liquid including a heat-resistant polyimide is printed and coated on a electrode layer. An orientation layer is formed by removing a solvent, polymerizing and curing. Next, a rubbing process of the orientation layer is performed.

And, a seal member of an ultraviolet curing type is printed and coated on a peripheral side of a substrate. a granular spacer member is distributed on one substrate, and is adhered on the substrate after a heating process is applied. At this time, in order to control a cell thickness to be uniform, a spacer member in which uniformity of a diameter of a particle is very excellent is used. Next, after dropping a necessary amount of an liquid crystal into the inner side of the seal member of the printed substrate by using an liquid injection device, this substrate, and a substrate on which a granular spacer is attached are bonded by using an alignment device.

Further, in order to prevent an ultraviolet ray deterioration of an liquid crystal, a display portion is covered by a mask, and a seal member is cured by illuminating an ultraviolet rays only on the seal member. Subsequently, an orientation of an liquid crystal is stabilized by a heating process. Then,

an LCD device is formed by attaching a polarization plate.

In a dropping method, since a necessary amount of an liquid crystal is dropped directly on a substrate by an liquid injection device, the injection time is reduced remarkably, and it is possible to maintain the injection time constantly regardless of a panel size. Further, it has a characteristics to cope with the linearization easily.

[Problem(s) to be Solved by the Invention]

But, according to a conventional manufacturing method, it may not possible to control uniformity of a cell thickness sufficiently.

Therefore, a manufacturing method for controlling the cell thickness uniformly is required.

[Means for Solving the Problem]

In order to solve the above-mentioned problems, a manufacturing method of an liquid crystal display device according to the present invention is a method in which a seal portion is formed by coating a seal member on a periphery of at least one substrate of a pair of substrates having an electrode to which an orientation process is applied, a predetermined amount of liquid crystal is dropped into an inside of the seal member of the substrate, a

spacer member is adhered on one substrate, and a panel is formed by attaching the substrates, and curing the seal member, and is characterized in that at least any one of the pair of substrates is accommodated into a vacuum container before attaching the substrates, and unnecessary attachment attached on the substrate is eliminated by reducing a pressure in the vacuum container.

According to the present invention, unnecessary attachment on the substrate into which is introduced and attached during a manufacturing process is eliminated by accommodating at least any one of the pair of substrates into a vacuum container before attaching the substrates, and by reducing a pressure in the vacuum container. Therefore, under the state that unnecessary attachment attached on the substrate is eliminated, it is possible to bond the substrates. Accordingly, an uniform cell thickness can be formed, and non-uniformity of a pre-tilt angle is suppressed. Thereby, uniformity of display is improved by preventing display smears. At this time, unnecessary attachment may be a dust or water which is introduced during a manufacturing process, an impurities included into the orientation layer, and a spacer member which has a feeble attachment on a substrate.

Further, it is preferable that the substrate on which a seal member is

coated is accommodated into a vacuum container before dropping the liquid crystal, and then the pressure is reduced. After dropping on the substrate, it is difficult to eliminate unnecessary attachment since dust, water, and impurities attached on the substrate are covered by an liquid crystal. But, unnecessary attachment such as dust, water, and impurities can be eliminated by maintaining the substrate on which a seal member is coated, under the reduced pressure before dropping the liquid crystal.

Further, it is preferable that a substrate on which the spacer member is adhered is accommodated into a vacuum container, and then the pressure is reduced. The spacer member adhered on the substrate has a different attachment power according to the particle shape, or a diameter of a particle. A spacer having a weak attachment can be moved easily when dropped liquid crystal is diffused into the cell, and this is a reason why a cell thickness becomes non-uniform. Therefore, a spacer having a weak attachment is eliminated before attaching the substrates by maintaining a substrate on which the spacer member is adhered under the reduced pressure. Therefore, it is possible make the cell thickness be more uniform.

Further, it is preferable that the pressure of vacuum container is reduced to below 133.3 Pa. It is possible to eliminate unnecessary

attachment within a short time by maintaining a substrate to a pressure below 133.3 Pa.

[Embodiment of the Invention]

Below, an embodiment of the present invention will be explained with referring to the drawings.

First Embodiment

FIG. 1 shows a flow chart of a manufacturing process of a manufacturing method of an liquid crystal display device according to an embodiment of the present invention. First of all, in a process for washing a substrate, in a process for washing a substrate, a glass substrate having a transparent electrode such as ITO on one peripheral side is washed, and then, in a process for printing an orientation layer, for example, a coating liquid including a heat-resistant polyimide is printed and coated on a electrode layer. In a provisional curing process, a solvent is eliminated, and a provisional curing is performed. In a curing process, an orientation layer is formed by polymerizing. Next, in a rubbing process, a rubbing process of the orientation layer is performed. Then, in a process for washing a substrate, the substrate to which rubbing is applied is washed.

Next, in a seal printing process, a seal portion is formed by printing

and coating a seal member of an ultraviolet rays curing type on a periphery of one substrate. Further, in a process for reducing a pressure, the substrate having the seal portion is accommodated into a vacuum container such as a glove box, and a pressure-reduction is performed. The substrate is maintained at a predetermined pressure, and for a predetermined time. Next, after an atmosphere pressure is provided, in a process for dropping an liquid crystal, a necessary amount of an liquid crystal is dropped into the inner side of the seal portion of the substrate by using an liquid injection device.

On the other hand, in a spacer distribution process, granular spacers are distributed on one substrate, and then in a spacer adhering process, the spacers are adhered on the substrate by a heating process. Further, in a process for reducing a pressure, the substrate on which the spacer member is attached is accommodated into a vacuum container such as a glove box, and a pressure-reduction is performed. The substrate is maintained at a predetermined pressure, and for a predetermined time. Next, after an atmosphere pressure is provided, in a attaching process, this substrate, and a substrate on which a granular spacer is attached are bonded by using an alignment device.

Further, in a seal curing process, in order to prevent an ultraviolet ray

deterioration of an liquid crystal, a display portion is covered by a mask, and a seal portion is cured by illuminating an ultraviolet rays only on the seal portion. Subsequently, an LCD device is formed by a heating process, and an attachment process of a polarization plate.

FIG. 2 shows a structure of an LCD device produced as described above. An LCD device A is composed of an liquid crystal 10 maintained in a predetermined gap which is set to a thickness of a segment glass substrate 1, a common glass substrate 2, a spacer member 9 in a panel surface, and a seal member into which the spacer member 8 is inserted. A color filter 7 including fine dots of RGB, a common electrode 6, and a polyimide orientation layer 4 are formed sequentially on an inside surface of the common glass substrate 2. Further, a segment electrode 5, and a polyimide orientation layer 3 are formed sequentially on an inside surface of the common glass substrate 2.

According to the embodiment of the present invention, a substrate on which the seal member is coated is accommodated into a vacuum container, before dropping the liquid crystal, and then the pressure is reduced. Then, the substrate is maintained at a predetermined pressure, and for a predetermined time. Therefore, unnecessary attachment of the substrate

such as dust, water, and impurities can be eliminated. Since dust, water, and impurities do not exist on the substrate, uniformity of a cell thickness can be improved. Further, non-uniformity of a pre-tilt angle is suppressed. the spacers having a weak attachment on the substrate can be eliminated by scattering. Therefore, it is possible to control movement of the spacers due to flow of an liquid crystal sealed between the substrates, and to improve uniformity of a cell thickness.

At this time, it is preferable that the reduced pressure is set to below 133.3 Pa. It is more preferable that the reduced pressure is set to below 133.3 Pa, and above 66.6 Pa. The reason is as follows. In case of above 133.3 Pa, it take a long time to eliminate unnecessary attachment. Further, it is possible to eliminate unnecessary attachment sufficiently at above 66.6 Pa.

Further, after maintaining the substrate under the reduced pressure, it is preferable that the time until an liquid crystal is dropped is set to be short. In case that the pressure is set to below 133.3 Pa, the preferable time is set to within 5 minute, and more preferable time is set to within 2 minute. By shortening the time until an liquid crystal is dropped, it is possible to control the amount of dust or water attached on the substrate as the time passes by.

According to the present embodiment, an example in which the substrate on which a seal member is coated, and the substrate on which a spacer is distributed are maintained under the reduced pressure is enumerated. But it is preferable that the substrates are maintained under the reduced pressure even after the orientation process. The reason is as follows. Even when there are parts which do not contact the liquid crystal, the dust introduced into the orientation layer is exposed to the inside surface, and is contacted to the liquid crystal.

Below, the present invention will be explained in detail by taking an example.

(Example 1)

A glass substrate(300mm×400mm) having ITO electrode layer to which an orientation process is applied is prepared. The glass substrate having the seal portion formed by coating a seal member is accommodated into a glove box. The pressure of the glove box is reduced, and the glass substrate is maintained at the pressure ranging from 533.2 Pa to 66.6 Pa for 30 seconds or 90 seconds. Then, after an atmosphere pressure is provided, after 2 minutes, an liquid crystal is dropped into the inner side of the seal portion. The glass substrate on which a spacer is attached is maintained at

the pressure which is same to that of the glass substrate on which the seal member is coated, for 30 seconds or 90 seconds. Then, the glass substrate on which spacers are distributed are arranged at the atmosphere. After 2 minutes, two substrates are bonded, and an LCD device(NO. 1-6) having a structure described in FIG. 2 are manufactured.

In connection with the manufactured display device, a difference of a panel transmissivity is measured when a duty driving of 1/300, and a multiplex driving of 100Hz are performed. To be more specific, the difference between the transmissivity of the portion which are not contacted to the liquid crystal in case of bonding, and transmissivity of a panel when being fixed to a driving voltage reaching to 50% of maximum transmissivity of a static driving is measured. In FIG. 3, the relationships between the difference of a panel transmissivity of an LCD device manufactured after being maintained at the predetermined for 30 seconds or 90 seconds, and maintenance pressure are shown.

From this relationships, it is to be understood that a transmissivity difference can be reduced by maintaining the substrate under the reduced pressure. Especially, it is also to be understood that a transmissivity difference can be almost eliminated and display smears can be suppressed

by maintaining the substrate at below 133.3 Pa for 90 seconds.

Further, at the same time as when the substrate on which a spacer member is attached is maintained at the reduced pressure, the change of the number of the spacer members was observed by a microscope. In FIG. 4, the relationships between a maintenance pressure and a remaining rate of the spacers are shown.

From this, it is to be understood that the spacer having a weak attachment on the substrate is eliminated by maintaining the substrate on which a spacer member is attached at the reduced pressure.

[Effect of the Invention]

As explained above, in a manufacturing method of an liquid crystal display device according to the present invention, at least one substrate of a pair of substrates having an electrode to which an orientation process is applied is maintained at the reduced pressure before attaching the substrates. Therefore, unnecessary attachment attached on the substrate is eliminated, thereby improving uniformity of a cell thickness. Accordingly, display smears can be prevented and a manufacturing method of an liquid crystal display device in which uniformity of a cell thickness is improved is provided.

Further, according to a manufacturing method of the present invention,

the substrate on which a seal member is coated is maintained at the reduced pressure before dropping an liquid crystal. Therefore, unnecessary attachment such as dust, water, and impurities can be eliminated easily, thereby improving uniformity of a cell thickness.

Further, according to a manufacturing method of the present invention, the substrate on which a spacer member is attached is maintained at the reduced pressure. the spacer member having a weak attachment is eliminated before attaching the substrates, thereby improving uniformity of a cell thickness.

Further, according to a manufacturing method of the present invention, the substrate is maintained at the reduced pressure which is below 133.3 Pa. Therefore, unnecessary attachment such as dust, water, and impurities can be eliminated within a short time, thereby reducing the manufacturing time of an LCD device.

[Description of Drawings]

FIG. 1 shows a flow chart of a manufacturing process of a manufacturing method according to the first embodiment of the present invention.

FIG. 2 shows a structure of an LCD device obtained by a manufacturing method according to the first embodiment of the present invention.

FIG. 3 is a diagram showing the relationships between the difference of a panel transmissivity, and a maintenance pressure in the example of the present invention.

FIG. 4 is a diagram showing the relationships between a maintenance pressure and a remaining rate of the spacers in the example of the present invention.